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US 4615627 A
US 4336971 A

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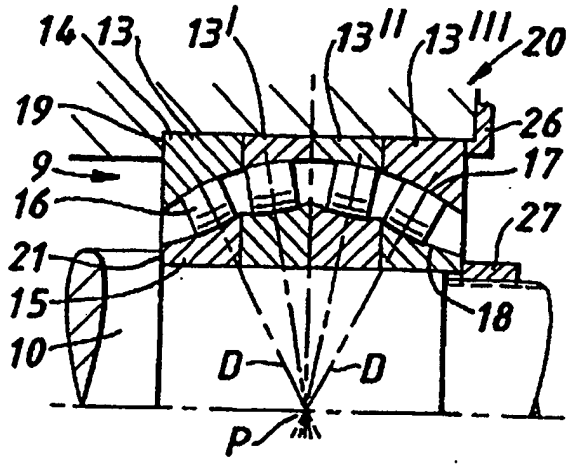
(54) Abstract Title
Shaft Bearing Arrangements

(57) A bearing arrangement for supporting a shaft or spindle (10) employs sets of rolling elements such as rollers (16) disposed side-by-side in rows. The rollers (16) contact curvilinear confronting surfaces (17, 18) of inner and outer rings (14, 15) extending laterally of the arrangement. The sets of rollers (16) are inclined in relation to the curvature of surface (17, 18) of the associated rings (14, 15) and projections of central planes extending perpendicularly to the rotational axes of the rollers (16) all intersect at a common point (P) acting as a load centre. The rollers (16) are free to move laterally in relation to at least one of the confronting surfaces (17, 18) in order to accommodate misalignment between the axis of the shaft (10) and the axes of rotation of the sets of rollers (16).

FIG. 2.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1.

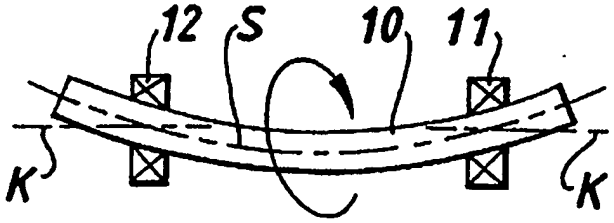


FIG. 2.

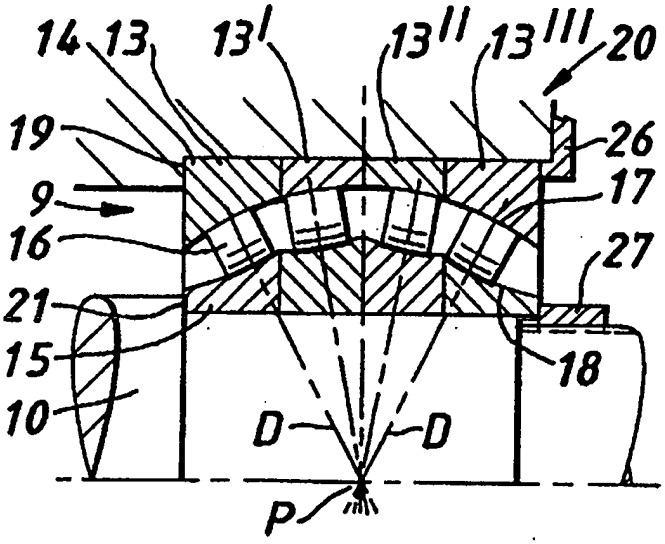


FIG. 3.

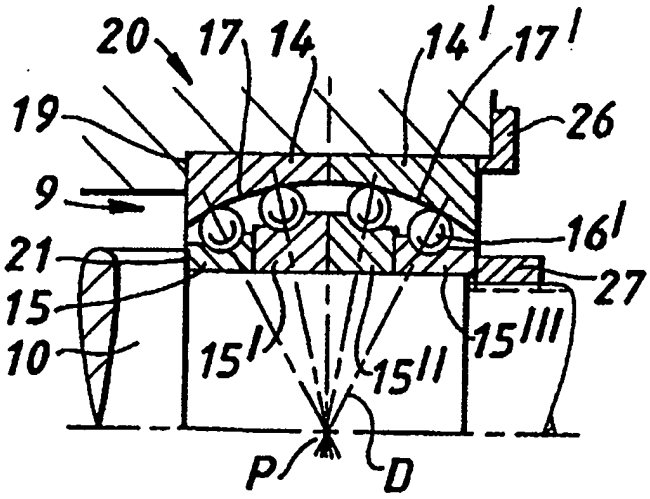


FIG. 4.

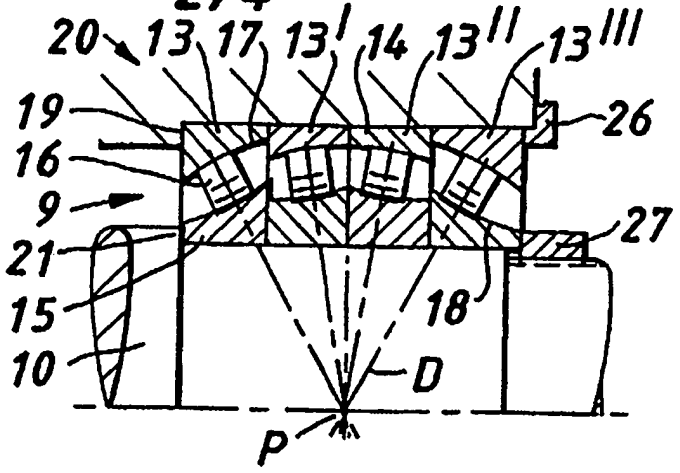


FIG. 5.

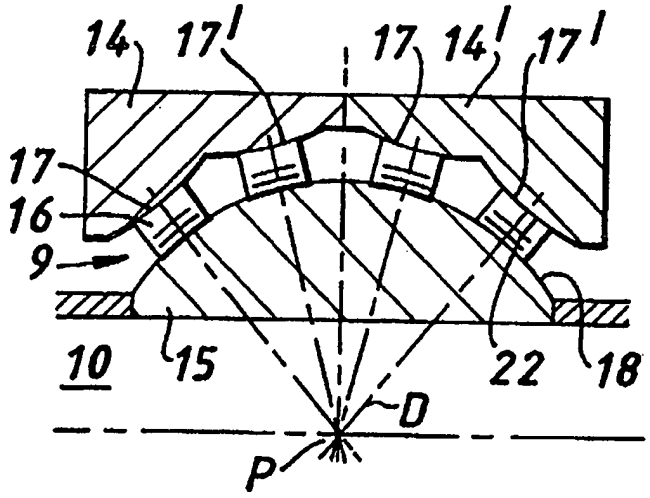


FIG. 6.

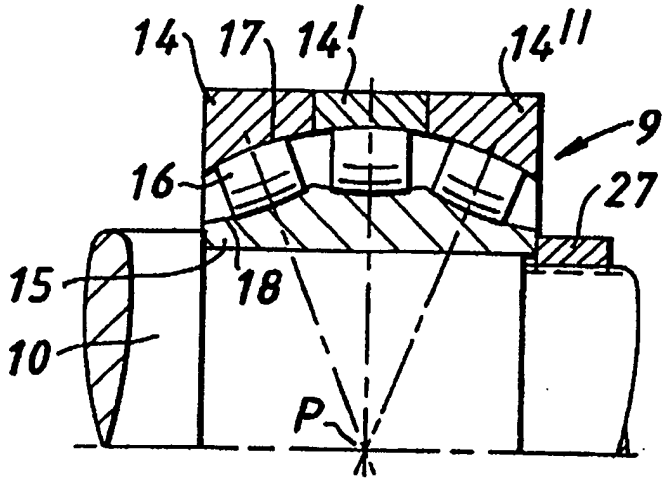


FIG. 7.

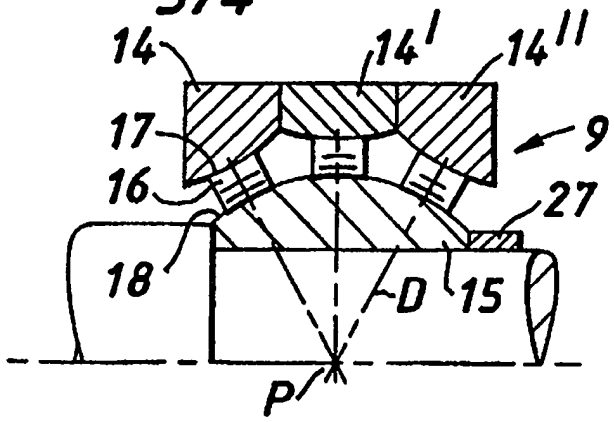


FIG. 8.

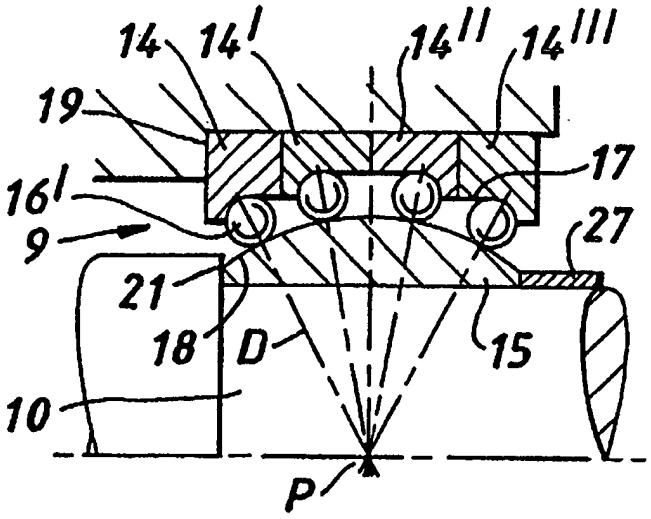


FIG. 9.

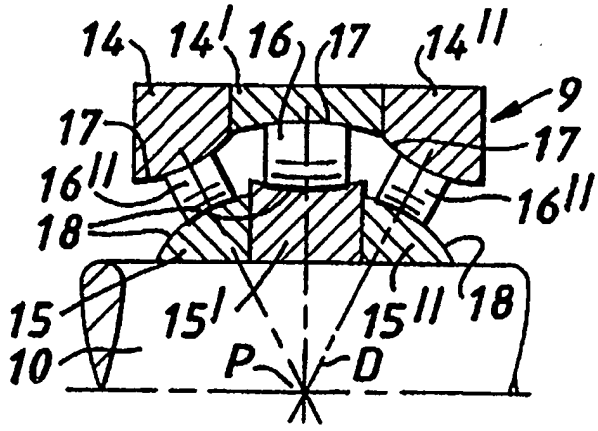
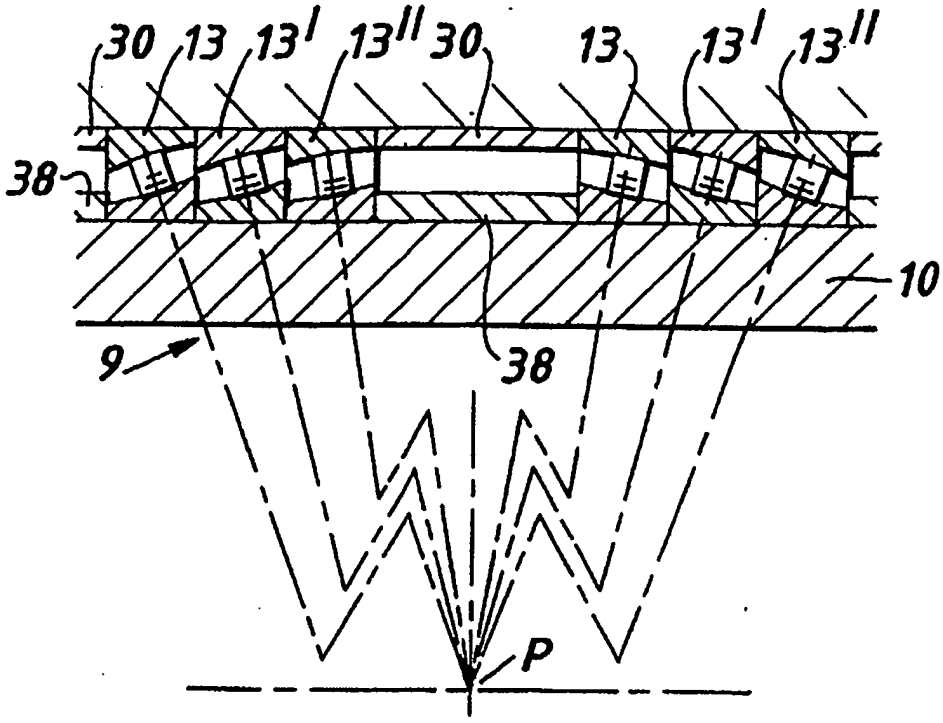


FIG.10.


30
13
13I
13II
30
13
13I
13II
38
10
9
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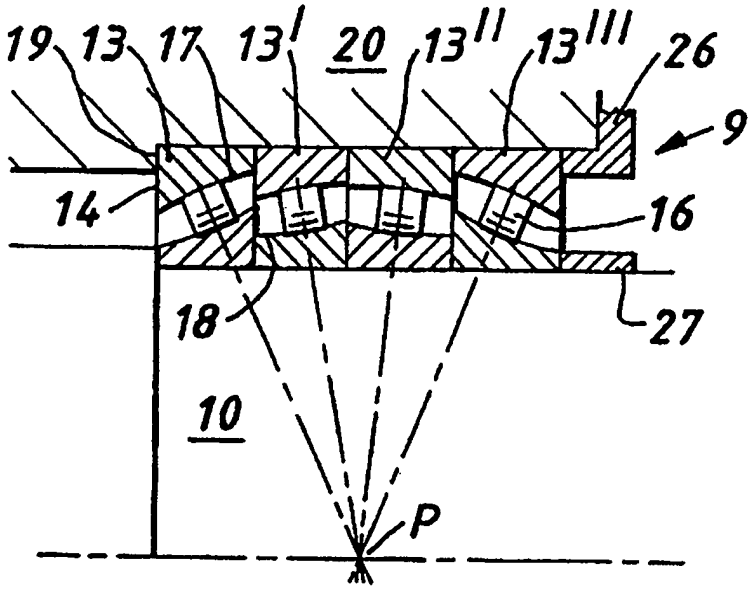
P

FIG.11.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13I
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13II
13III
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SHAFT BEARING ARRANGEMENTS

The present invention relates to bearing arrangements for use as rotational support for a driven shaft or spindle.

Hitherto it has not been possible to provide a shaft bearing arrangement usable in a wide range of applications – typically engine crankshafts, rolls in steel paper or rubber manufacture and pumps – which is able to accept both radial and axial loading and yet is capable of coping with misalignment in the axis of rotation of the shaft.

Figure 1 shows a shaft 10 rotatably supported by bearings 11, 12. The shaft 10 is shown to have an exaggerated curvilinear form and the bearings 11, 12 have to cope with the misalignment between the bearing axes K and the associated shaft axis S. Such misalignment can vary during operation and in any event depends on the particular application to which the shaft is put. Where such misalignment is expected it is known to use a self-aligning bearing with a double row of balls or rollers in contact with a common concave outer surface. Such a bearing is not particularly efficient at coping with radial and axial loading. Thus, bearings designed to cope with misalignment are not capable of withstanding high radial and axial loading and vice versa.

An object of the invention is to provide an improved form of bearing arrangement capable of fulfilling such a need.

According to the invention there is provided a bearing arrangement for rotatably supporting a shaft, the bearing arrangement comprising sets of rolling elements disposed in at least three rows and in contact with confronting surface of inner and outer rings with the inner ring or rings fitted to the shaft, wherein central planes through the rolling elements normal to the rolling axes thereof intersect at a common point forming a common load centre of the bearing arrangement and all the sets of rolling elements co-operate to absorb radial and axial loading during use.

Practical embodiments of the invention can take a variety of forms with balls or rollers as rolling elements.

The outer or inner rings of the bearing arrangement may be made up of individual rings each in contact with one or more rows of rolling elements and disposed side-by-side or a single common ring for all the rows. Where there is a single common outer ring then the inner ring is made up of individual rings in mutual axial abutment and vice versa. The radii of curvature of all the rolling elements and the complementary surfaces of the rings in contact therewith may be nominally the same although in some constructions the value and/or the sense (i.e. concave or convex) of the radii may differ significantly.

The invention may be understood more readily, and various other aspects and features of the invention may become apparent, from consideration of the following description.

Embodiments of the invention will now be described, by way of examples only, with reference to the accompanying drawings, wherein:

Figure 1 is a schematic representation of a shaft and bearing arrangement in side view in which the effect of shaft misalignment is depicted and

Figures 2 to 11 are sectional side views of bearing arrangements constructed in accordance with the invention and designed to mitigate the effects of shaft misalignment and to absorb both radial and axial loads.

Throughout the following description and in the accompanying drawings like reference numerals are used to denote the same or analogous features and components.

As shown in Figure 2, a bearing arrangement 9 constructed in accordance with the invention serves to support a shaft 10 for rotation. The arrangement 9 is composed of four individual roller bearings 13, 13', 13", 13"' each with an outer ring 14, an inner ring 15 and rollers 16 therebetween. The rings 14, 15 of the bearings 13-13"' have concave confronting surfaces 17, 18 and the rollers 16 have convex outer surfaces 22 with a matching curvature to the surfaces 17, 18. The outer surfaces 17 combine with a common centre of curvature. The radii of curvature of the surfaces 17, 18, 22 are nominally the same i.e. they match one another within standard design principles and tolerances. Diametric planes D normal to the rolling axis of each roller 16 intersect a common point P on the axis of the shaft 10 which acts as a common load centre. In this embodiment, the point P lies on another diametric plane of separation DP where the bearing rings 14, 15 of the bearings 13', 13" abut one another. The outer ring 14 of the bearing 13 abuts a shoulder 19 of a housing 20 surrounding the arrangement 9 while the inner ring 15 of the bearing

13 abuts a shoulder 21 on the shaft 10 aligned with the shoulder 19. The rings 14, 15 of the intermediate bearings 13', 13" abut one another and the endmost bearings 13, 13"'. Releasable clamping means 26, 27 serves to retain the bearing rings 14, 15 of the outermost bearing 13"'. The bearing arrangement 9 is capable of absorbing both high radial and axial loads yet is able of coping with misalignment as in Figure 1 because the bearings 13-13"' can effectively pivot about the common load centre P and yet can yield relative to one another in axial and radial planes.

Figure 3 shows another bearing arrangement 9 constructed in accordance with the invention. This arrangement 9 employs four inner bearing rings 15-15"' each with a concave surface 18 in angular contact with a row of balls 16'. The two rows of balls 16' associated with innermost rings 15, 15' contact the concave surface 17 of a single common outer ring 14 while the two rows of balls 16' associated with the outermost rings 15", 15"' contact the concave surface 17' of a common outer ring 14'. The outer surfaces 17, 17' combine with a common centre of curvature as in the previous embodiment. Also, as with the previous embodiment, the respective contact angles of the balls 16', equivalent to the planes P, again intersect at the common point P acting as the load centre. The point P lies on the diametric plane of separation and abutment DP between the outer rings 14, 14' and the inner rings 15', 15".

The embodiment represented in Figure 4 is similar to that represented in Figure 2 except that the radii of curvature of the surfaces 17, 18 of the bearings 13', 13" are not nominally the same as the bearing 13, 13"' but significantly different.

Figure 5 depicts a further embodiment of the invention where there is a single common inner ring 15 with a convex surface 18. Two rows of rollers 16 with concave outer surfaces 22 engage individual convex surfaces 17, 17' of a common outer ring 14, 14' and with the common surface 18.

In the previous embodiments there is an even number of rows of rolling elements – balls 16' or rollers 16. Figures 6 and 7 depict modified constructions with three rows of rollers 16 with a common inner ring 15 and individual outer rings 14, 14', 14". In these embodiments the common load centre P does not lie on the diametric plane of separation DP between the rings 14, 14', 14".

Figure 8 depicts another construction similar to Figure 3 but with individual outer rings 14-14"' with individual contact surfaces 17 in angular contact with the balls 16' and a single common inner ring 15 with a common contact surface 18.

In the aforedescribed embodiments the rolling elements in the rows have been of the same type, balls or concave or convex rollers. It is however possible to provide an arrangement with different types of rolling elements. Thus Figure 9 shows a three-row bearing arrangement with convex central rollers 16 and concave outer rollers 16".

Where the shaft has a large diameter a number of individual bearing sets like Figure 2 can be adopted and spaced apart in sets with spacers 30, 38 as shown in Figure 10. The disposition of the point P acting as the common load centre need not be symmetrical relative to the bearing element rows as in the embodiments represented in Figures 2 to 10. Figure 11 thus shows an

arrangement similar to Figure 4 but where the point P is asymmetrical to the bearing rings 14', 15', 14", 15" of the intermediate bearings 13', 13".

CLAIMS

1. A bearing arrangement for rotatably supporting a shaft, the bearing arrangement comprising sets of rolling elements disposed in at least three rows and in contact with confronting surface of inner and outer rings with the inner ring or rings fitted to the shaft, wherein central planes through the rolling elements normal to the rolling axes thereof intersect at a common point forming a common load centre of the bearing arrangement and all the sets of rolling elements co-operate to absorb radial and axial loading during use.

2. A bearing arrangement according to claim 1, wherein the rolling elements are rollers.

3. A bearing arrangement according to claim 2, wherein the rolling elements have convex outer surfaces.

4. A bearing arrangement according to claim 2, wherein the rolling elements have concave outer surfaces.

5. A bearing arrangement according to claim 1, wherein the rolling elements are balls.

6. A bearing arrangement according to claim 3, wherein the surfaces of the inner and outer rings which contact each row of rollers are provided on complementary pairs of individual inner and outer rings.

7. A bearing arrangement according to claim 3, 4 or 5, wherein each row of balls or rollers is in contact with one confronting surface of an individual inner or outer ring and several rows of balls or rollers are in contact with a common confronting surface of an individual outer or inner ring.

8. A bearing arrangement according to claim 7 when appended to claim 5, wherein each row of balls is in angular contact with said one confronting surface.

9. A bearing arrangement according to any one of the preceding claims, wherein the radii of curvature of all the rolling elements and the confronting surfaces of the rings are nominally the same.

10. A bearing arrangement according to any one of claims 1 to 8, wherein the radii of curvature of the rolling elements and confronting surface of some of the rows differ significantly from one another.

11. A bearing arrangement according to claim 10, wherein the difference in the radii of curvature extend only to the value of such radii.

12. A bearing arrangement according to claim 10, wherein the difference in the radii of curvature extends at least to the sense of curvature.

13. A bearing arrangement according to any one of claims 1 to 12, wherein the common point also lies on a separation plane between a pair of inner or outer rings where these rings abut one another.

14. A bearing arrangement according to claim 6, 7 or 8 or any one of claims 9 to 13 when appended to claim 6, 7 or 8, wherein the individual inner or outer rings are all in mutual abutment.

15. A bearing arrangement according to claim 6, 7 or 8 or any one of claims 9 to 13 when appended to claim 6, 7 or 8, wherein some of the individual inner or outer rings are spaced apart from one another.

16. A bearing arrangement substantially as described herein with reference to, and as illustrated in, any one or more of Figures 2 to 11 of the accompanying drawings.

Amendments to the claims have been filed as follows

CLAIMS

1. A bearing arrangement rotatably supporting a shaft, the bearing arrangement comprising sets of rolling elements in the form of rollers disposed in at least three rows and in contact with curvilinear confronting surfaces of inner and outer rings extending laterally of the arrangement with the inner ring or rings fitted to the shaft to rotate therewith, wherein projections of central planes extending perpendicularly to rotational axes of the rollers all intersect at a common point forming a common load centre of the bearing arrangement, all the sets of rollers cooperate to absorb radial and axial loading during use and each set of rollers is also adjustably free to move circumferentially in relation to the curvilinear confronting surface of at least one of the rings with which the set of rollers is in contact in the event of misalignment between the axis of the shaft and the axes of rotation defined by the sets of rollers.

2. A bearing arrangement rotatably supporting a shaft, the bearing arrangement comprising sets of rolling elements in the form of balls disposed in at least three rows and in contact with curvilinear confronting surfaces of inner and outer rings extending laterally of the arrangement with the inner ring or rings fitted to the shaft to rotate therewith, wherein projections of central planes defining the contact angles of the balls relative to the confronting surfaces all intersect at a common point forming a common load centre of the bearing arrangement, all the sets of balls cooperate to absorb radial and axial loading during use and each set of balls is also adjustably free to move circumferentially in relation to the curvilinear confronting surface of at least one of

the rings with which the set of balls is in contact in the event of misalignment between the axis of the shaft and the axes of rotation defined by the sets of balls.

3. A bearing arrangement according to claim 1, wherein the rollers have convex outer surfaces.

4. A bearing arrangement according to claim 1, wherein the rollers have concave outer surfaces,

5. A bearing arrangement according to any one of claims 1, 3 or 4, wherein the radii of curvature of all the rolling elements and the confronting surfaces of the rings are nominally the same.

6. A bearing arrangement according to any one of claims 1, 3 or 4, wherein the radii of curvature of the rolling elements and confronting surface of some of the rows differ significantly from one another.

7. A bearing arrangement according to claim 6, wherein the difference in the radii of curvature extend only to the value of such radii.

8. A bearing arrangement according to claim 6, wherein the difference in the radii of curvature extends at least to the sense of curvature.

9. A bearing arrangement according to claim 3 or any one or more of claims 5 to 8 when appended to claim 3, wherein the surfaces of the inner and outer rings which contact each row of rollers are provided on complementary pairs of individual inner and outer rings.

10. A bearing arrangement according to claim 1 or 2, wherein each row of balls or rollers is in contact with one confronting surface of an individual inner or outer ring and several rows of balls or rollers are in contact with a common confronting surface of an individual outer or inner ring.

11. A bearing arrangement according to claim 1, wherein each row of balls isin angular contact with one confronting surface of an individual inner or outer ring and several rows of balls are in contact with a common confronting surface of an individual outer or inner ring.

12. A bearing arrangement according to claim 9, 10 or 11, wherein the individual inner or outer rings are all in mutual abutment.

13. A bearing arrangement according to claim 9, 10 or 11, wherein some of the individual inner or outer rings are spaced apart from one another.

14. A bearing arrangement according to any one of claims 1 to 13, wherein the common point also lies on a separation plane between a pair of inner or outer rings where these rings abut one another.

15. A bearing arrangement substantially as described herein with reference to, and as illustrated in, any one or more of Figures 2 to 11 of the accompanying drawings.

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Application No: GB 0030824.7
Claims searched: All
Examiner: Helen Edwards
Date of search: 10 April 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): F2A: AD36

Int Cl (Ed.7): F16C19/ALL

Other: ONLINE DATABASE: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 4615627 A (NTN-BOWER) See embodiment 8	1, 2
A	US 4336971 A (THE TIMKEN COMPANY)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.